ment technique used in the fabrication of displays, such as organic light emissive diode displays. A stiff reinforcement lid is mounted on a thin substrate to encapsulate the OLED cells. The lid serves to reinforce the thin flexible substrate and protect it from breakage. It comprises preferably of metal or other materials that have higher stiffness and ductility than the thin substrate. The fabricated display is compatible for integration into chip cards and other flexible applications.

US20020001046 A1 entitled "Apparatuses and methods for forming assemblies" describes various means to form flexible active-matrix displays along a length of flexible substrate. Another embodiment of the invention relates to forming multiple flexible displays along a continuous flexible substrate. Another embodiment of the invention relates to forming a flexible display along a flexible reflective substrate.

US20030184704 entitled "Display Device and Method of Manufacturing the Same" describes a display device comprising a first plastic substrate, a first adhesion layer formed in a first region of the first plastic substrate, the first region being a region where a pixel region is to be formed thereon, a second adhesion layer formed in a peripheral region outside of the first region of the first plastic substrate, a first thin glass layer formed on the first and second adhesion layers, a plurality of active elements formed on the first thin glass layer in one-to-one relation with a plurality of pixels, a display part formed on the first thin glass layer, the display part corresponding to the pixel region and being driven by the plurality of active elements, and an opposing substrate formed over the display part. Such laminated structures can provide a more environmentally tolerant substrate with a greater flexibility. Nonetheless, continuous flexing of such structures can lead to failure and may not provide the process compatibility necessary for OLED display processing.

In many applications, flexibility over time is not necessary so that a flexible display screen may be coupled to a substrate to provide a conformable display that is fixed in shape. Hence, the display screen is flexed only a limited number of times before being fixed in position. For example, WO2003020545 entitled "Conformable Vehicle Display" discloses a conformable vehicle display that includes a flexible display screen coupled to a substrate. The substrate is a curved transparent substrate that is adapted to be coupled to a vehicle component having a curved exterior surface. The flexible display screen is at least partially separate from the exterior surface of the vehicle component and has a luminescent display. The exterior surface of the vehicle component is visible through the flexible display screen and the substrate when the flexible display screen is not activated. The flexible display screen may be a transparent organic light emitting diode display device. However, such a design still requires that an entire display screen itself be flexible, and therefore suffers from the same environmental exposure and lifetime problems found in the OLED flexible display art.

U.S. Pat. No. 5,652,930 discloses a curved information display may be adapted as an exterior display conforming to curved surfaces of a camera casing. In such embodiment, organic electroluminescent material is applied in predetermined patterns to a flexible support, and the flexible support is applied to a rigid support, such as the camera casing or other structure conforming to the shape of the camera casing. The electroluminescent patterns are then coupled electrically to a camera control for selectively applying voltages to the patterns, causing the patterns to luminesce. The flexible display is described as comprising a transparent flexible substrate, and a first transparent conductor, an organic electroluminescent pattern layer, and a second transparent conductor, respectively, coated or otherwise deposited on the flexible substrate, along with a sealing layer **208** applied for mechanical and environmental protection. Such flexible display design still fails to teach encapsulation of a curved display in a manner that solves the environmental exposure and lifetime problems found in the OLED flexible display art.

In an alternative approach to making a curved display or illuminator, a curved, rigid substrate may be employed having the desired display shape, and the materials comprising the device are formed directly on the curved substrate. Such a manufacturing process is described in US2004/0135160. Most display manufacturing equipment, however, is designed for planar surfaces so that the deposition of materials on a curved surface is difficult and the manufacturing infrastructure for supporting such deposition is not available.

There is a need therefore for an improved process for making solid-state OLED light emissive devices having a curved display surface for area illumination or information presentation.

SUMMARY OF THE INVENTION

In accordance with one embodiment, the present invention is directed towards a method of manufacturing an OLED device with a curved light-emitting surface comprising:

a) forming a flexible substrate and providing the flexible substrate in a flat configuration;

b) forming one or more OLEDs having a first electrode, one or more layers of organic material, at least one of which is light emitting formed over the first electrode, and a second electrode formed over the one or more layers of organic material, on the substrate;

c) forming a rigid, curved, encapsulating cover;

d) conforming the flexible substrate, electrodes, and one or more layers of organic material to the rigid, curved, encapsulating cover; and

e) sealing the conformed flexible substrate, electrodes, and one or more layers of organic material to the rigid, curved, encapsulating cover.

ADVANTAGES

The present invention has the advantage that it can provide an OLED device having a curved emission surface while employing manufacturing equipment that form OLEDs in a flat configuration. The curved emission surface may be advantageously employed in an area illumination light or in a display.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross section of an OLED having a curved light-emitting surface according to one embodiment of the present invention;

FIG. **2** is a cross section of a prior-art OLED device having a planar substrate;

FIG. **3** is a cross section of an OLED having a curved light-emitting surface according to an alternative embodiment of the present invention;